CLAIMS

1. A method for controlling temperature in a deposition process, comprising:
   positioning a microfeature workpiece in a deposition chamber;
   monitoring a first temperature from a first temperature sensor positioned outside the deposition chamber;
   monitoring a second temperature from a second temperature sensor positioned in the deposition chamber; and
   increasing an internal temperature in the deposition chamber from an initial temperature to a deposition temperature in accordance with a ramp profile by (a) comparing a control temperature to a target temperature, the control temperature alternating between the first temperature and the second temperature, the target temperature being determined in accordance with the ramp profile, and (b) selectively delivering heat to the deposition chamber in response to a result of the comparison.

2. The method of claim 1 wherein the control temperature is equivalent to the first temperature for a fixed first period of time and is equivalent to the second temperature for a fixed second period of time.

3. The method of claim 1 wherein the control temperature is equivalent to the first temperature for a first period of time and is equivalent to the second temperature for a second period of time, the first period of time being contiguous to and longer than the second period of time.

4. The method of claim 3 wherein the second period of time is selected to maintain the first temperature within a permissible operational range.

5. The method of claim 3 wherein the second period of time is no greater than about two minutes.

6. The method of claim 1 wherein the control temperature is equivalent to the first temperature for a first period of time, is equivalent to the second temperature for a second period of time, is equivalent to the first temperature for a third period of time, and is equivalent to the second temperature for a fourth period of time, each of the first and third periods of time being different from both the second period of time and the fourth period of time.

7. The method of claim 1 wherein the control temperature is equivalent to the first temperature for a first period of time, is equivalent to the second temperature for a second period of time, is equivalent to the first temperature for a third period of time, and is equivalent to the second temperature for a fourth period of time, each of the first and third periods of time being greater than either of the second and fourth periods of time.

8. The method of claim 1 wherein the control temperature switches from the second temperature to the first temperature when the first temperature reaches or exceeds a trigger temperature.

9. The method of claim 1 wherein the control temperature switches from the first temperature to the second temperature when the second temperature reaches or exceeds a first trigger temperature, and switches from the second temperature to the first temperature when the first temperature reaches or exceeds a second trigger temperature.

10. The method of claim 1 wherein the control temperature switches from the first temperature to the second temperature when the second temperature reaches or exceeds a first trigger temperature, switches from the second temperature to the first temperature when the first temperature reaches or exceeds a second trigger temperature, switches from the first temperature to the second temperature when the second temperature reaches or exceeds a third trigger temperature, and switches from the second temperature to the first

temperature when the first temperature reaches or exceeds a fourth trigger temperature, wherein the second trigger is temperature is different from the fourth trigger temperature.

11. The method of claim 1 wherein the control temperature switches from the first temperature to the second temperature after a fixed period of time and the control temperature switches from the second temperature to the first temperature when the first temperature reaches or exceeds a trigger temperature.

12. The method of claim 1 wherein the control temperature is equivalent to the first temperature for a first period of time and is equivalent to the second temperature for a second period of time, and wherein the heat is delivered to the deposition chamber at a higher rate during the second period than during the first period.

13. The method of claim 1 wherein the control temperature is a first control temperature, the method further comprising holding the internal temperature of the deposition chamber in a deposition temperature range, which encompasses the deposition temperature, during a deposition phase by:

determining a second control temperature as a function of both the first temperature and the second temperature;

comparing the second control temperature with the deposition temperature in a second comparison; and

selectively delivering heat to the deposition chamber in response to a result of the second comparison.

14. The method of claim 1 further comprising allowing the internal temperature of the deposition chamber to decrease below the deposition temperature after the deposition phase.

15. The method of claim 1 further comprising maintaining the internal temperature of the deposition chamber within a deposition temperature range that encompasses the deposition temperature, and, with the internal temperature within the deposition temperature range, delivering a precursor to the deposition chamber to deposit a material on the microfeature workpiece.

16. A system for depositing a material on a microfeature workpiece, comprising:
an enclosure defining a deposition chamber;
a heater adapted to deliver heat to the deposition chamber;
a first temperature sensor outside the deposition chamber adapted to generate a first temperature signal corresponding to a first temperature outside the deposition chamber;
a second temperature sensor in the deposition chamber adapted to generate a second temperature signal corresponding to a second temperature in the deposition chamber; and
a programmable controller operatively coupled to the heater, the first temperature sensor, and the second temperature sensor, the controller being programmed to heat the microfeature workpiece from an initial temperature to a deposition temperature in accordance with a ramp profile by (a) comparing a control temperature to a target temperature, the control temperature alternating between the first temperature and the second temperature, and the target temperature being determined in accordance with the ramp profile, and (b) controlling the heater to selectively deliver heat to the deposition chamber in response to a result of the comparison.

17. The system of claim 16 wherein the controller sets the control temperature equivalent to the first temperature for a first period of time and sets the control temperature equivalent to the second temperature for a second period of time.

18. The system of claim 16 wherein the controller sets the control temperature equivalent to the first temperature for a first period of time and sets the control temperature equivalent to the second temperature for a second period of time, the first period of time being longer than the second period of time.

19. The method of claim 18 wherein the second period of time is selected to maintain the first temperature within a permissible operational range.

20. The system of claim 16 wherein the controller sets the control temperature equivalent to the first temperature for a first period of time, sets the control temperature equivalent to the second temperature for a second period of time, sets the control temperature equivalent to the first temperature for a third period of time, and sets the control temperature equivalent to the second temperature for a fourth period of time, each of the first and third periods of time being different from both the second period of time and the fourth period of time.

21. The system of claim 16 wherein the controller sets the control temperature equivalent to the first temperature for a first period of time, sets the control temperature equivalent to the second temperature for a second period of time, sets the control temperature equivalent to the first temperature for a third period of time, and sets the control temperature equivalent to the second temperature for a fourth period of time, each of the first and third periods of time being greater than either of the second and fourth periods of time.

22. The method of claim 16 wherein the controller switches the control temperature from the second temperature to the first temperature when the first temperature reaches or exceeds a trigger temperature.

23. The method of claim 16 wherein the controller switches the control temperature from the first temperature to the second temperature when the

second temperature reaches or exceeds a first trigger temperature, and switches the control temperature from the second temperature to the first temperature when the first temperature reaches or exceeds a second trigger temperature.

24. The method of claim 16 wherein the controller switches the control temperature from the first temperature to the second temperature when the second temperature reaches or exceeds a first trigger temperature, switches the control temperature from the second temperature to the first temperature when the first temperature reaches or exceeds a second trigger temperature, switches the control temperature from the first temperature to the second temperature when the second temperature reaches or exceeds a third trigger temperature, and switches the control temperature from the second temperature to the first temperature when the first temperature reaches or exceeds a fourth trigger temperature, wherein the second trigger is temperature is different from the fourth trigger temperature.

25. The method of claim 16 wherein the controller switches the control temperature from the first temperature to the second temperature after a fixed period of time and the controller switches the control temperature from the second temperature to the first temperature when the first temperature reaches or exceeds a trigger temperature.

26. The system of claim 16 wherein the control temperature is a first control temperature, the controller being further programmed to hold a temperature of the microfeature workpiece in a deposition temperature range, which encompasses the deposition temperature, during a deposition phase by:

determining a second control temperature as a function of both the first temperature and the second temperature;

comparing the second control temperature with the deposition temperature in a second comparison; and

controlling the heater in response to a result of the second comparison.

27. A method for controlling temperature in a deposition process, comprising:
positioning a microfeature workpiece in a deposition chamber of an enclosure;
monitoring a first temperature from a first temperature sensor positioned outside the deposition chamber;
monitoring a second temperature from a second temperature sensor positioned in the deposition chamber;
alternating a control temperature between the first temperature and the second temperature;
varying a target temperature in accordance with a ramp profile;
comparing the control temperature to the target temperature; and
selectively delivering heat to the deposition chamber in response to a result of the comparison.

28. The method of claim 27 wherein the control temperature is equivalent to the first temperature for a first period of time and is equivalent to the second temperature for a second period of time, the first period of time being longer than the second period of time.

29. The method of claim 28 wherein the second period of time is selected to maintain the first temperature within a permissible operational range.

30. The method of claim 27 wherein the control temperature is equivalent to the first temperature for a first period of time, is equivalent to the second temperature for a second period of time, is equivalent to the first temperature for a third period of time, and is equivalent to the second temperature for a fourth period of time, each of the first and third periods of time being greater than either of the second and fourth periods of time.

31. The method of claim 27 wherein the control temperature is equivalent to the first temperature for a first period of time and is equivalent to the second temperature for a second period of time, and wherein the heat is delivered to the deposition chamber at a higher rate during the second period than during the first period.

32. The method of claim 27 wherein the control temperature is a first control temperature, the method further comprising holding the internal temperature of the deposition chamber in a deposition temperature range, which encompasses the deposition temperature, during a deposition phase by:

determining a second control temperature as a function of both the first temperature and the second temperature;

comparing the second control temperature with the deposition temperature in a second comparison; and

selectively delivering heat to the deposition chamber in response to a result of the second comparison.

33. A method for depositing a material on a microfeature workpiece, comprising:

positioning a microfeature workpiece in a deposition chamber of an enclosure;

monitoring a first temperature from a first temperature sensor positioned outside the deposition chamber;

monitoring a second temperature from a second temperature sensor positioned in the deposition chamber;

heating the microfeature workpiece from an initial temperature to a deposition temperature in accordance with a ramp profile by (a) comparing a target temperature with a first control temperature in a first comparison, the target temperature being determined in accordance with the ramp profile and the first control temperature alternating between the first temperature and the second temperature, and (b) controlling a heater in response to a result of the first comparison;

determining a second control temperature as a function of both the first temperature and the second temperature;

maintaining a temperature of the microfeature workpiece within a deposition temperature range that encompasses the deposition temperature by (a) comparing the deposition temperature with the second control temperature in a second comparison, and (b) controlling the heater in response to a result of the second comparison; and

while maintaining the temperature of the microfeature workpiece within the deposition temperature range, delivering a precursor to the deposition chamber to deposit a material on the microfeature workpiece and an inside surface of a wall of the enclosure.

34. The method of claim 33 wherein the heater is a radiant heater and the deposited material reflects radiant heat.

35. A system for depositing a radiant heat-reflective material on a microfeature workpiece, comprising:

an enclosure including a wall and defining a deposition chamber, the wall having an inner surface bearing a radiant heat-reflective layer;

a gas supply adapted to deliver a precursor to the deposition chamber;

a radiant heater disposed outside the deposition chamber and adapted to direct radiant heat through the wall into the deposition chamber;

a first temperature sensor outside the deposition chamber adapted to generate a first temperature signal corresponding to a temperature outside the deposition chamber;

a second temperature sensor in the deposition chamber adapted to generate a second temperature signal corresponding to a temperature in the deposition chamber; and

a programmable controller operatively coupled to the heater, the first temperature sensor, and the second temperature sensor, the controller being programmed to:

control the heater during a heating phase to heat a microfeature workpiece from an initial temperature to a higher deposition temperature at which the precursor reacts to deposit the radiant heat-reflective material on the microfeature workpiece and on the radiant heat-reflective layer;

during a deposition phase, determine a combined temperature as a function of both the first temperature and the second temperature;

during the deposition phase, selectively control the heater to maintain the combined temperature in a range corresponding to a deposition temperature range that encompasses the deposition temperature; and

allow the microfeature workpiece to cool from the deposition temperature to a lower terminal temperature.

36. The system of claim 35 wherein the controller is programmed to calculate the combined temperature as a weighted average of the first temperature and the second temperature.

37. The system of claim 35 wherein the controller is programmed to heat the microfeature workpiece during the heating phase in accordance with a ramp profile by (a) comparing a control temperature to a target temperature, the control temperature alternating between the first temperature and the second temperature, and the target temperature being determined in accordance with the ramp profile, and (b) controlling the heater to deliver heat to the deposition chamber in response to a result of the comparison.

38. The system of claim 35 wherein each of the first and second temperature sensors comprises a thermocouple.

39. The system of claim 35 wherein the radiant heat-reflective layer has a reflectivity that changes as the material is deposited on successive microfeature workpieces.

40. A method for controlling temperature in a deposition process, comprising:
positioning a microfeature workpiece in a deposition chamber of an enclosure;
monitoring a first temperature from a first temperature sensor positioned outside the deposition chamber;
monitoring a second temperature from a second temperature sensor positioned in the deposition chamber;
heating the microfeature workpiece from an initial temperature to a deposition temperature by delivering radiant heat to the deposition chamber from a heater positioned outside the deposition chamber;
with the microfeature workpiece in a deposition temperature range that encompasses the deposition temperature, delivering a precursor to the deposition chamber and reacting the precursor to deposit a radiant heat-reflective reaction product on a surface of the microfeature workpiece and on an inner surface of the enclosure;
determining a control temperature as a weighted average of the first temperature and the second temperature; and
maintaining the microfeature workpiece at a temperature in the deposition temperature range by (a) comparing the deposition temperature with the control temperature, and (b) controlling the heater in response to a result of the second comparison.

41. The method of claim 40 wherein depositing the radiant heat-reflective reaction product on the surface of the microfeature workpiece reduces radiant heat transmissivity of a wall of the enclosure that is disposed between the heater and the microfeature workpiece.